Original Report

Tattoos as Risk Factors for Transfusion-Transmitted Diseases

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ABSTRACT

Background: Several infectious diseases have been found to be associated with tattooing, including some transfusion-transmitted diseases (TTDs). Information on tattooing has been included in screening interviews of prospective blood donors and may be a reason for deferral.

Methods: Review of articles identified through MEDLINE (and other computerized data bases) using medical subject heading (MeSH) terms and textwords for "tattooing," "transfusion," "hepatitis," "human immunodeficiency virus," "acquired immunodeficiency syndrome," "syphilis," "Chagas disease," "infection," "risk factors," and their combinations.

Results: There is strong evidence for the transmission of hepatitis B virus (HBV) infection, hepatitis C virus (HCV) infection, and syphilis by tattooing. Tattooing may also transmit the human immunodeficiency virus (HIV), although convincing evidence is still lacking. There is little or no evidence that other TTDs can be transmitted by tattooing. Epidemiologic studies to date have shown a large variation in odds ratio estimates of the association between tattooing and HBV, HCV, and HIV infections.

Conclusions: Further studies are required to clarify the risk of tattoos in transmitting infectious diseases through blood transfusions. A reassessment of tattoos as a screening criterion among blood donors is justified.

Key Words: *AIDS, Chagas disease, hepatitis B, hepatitis C, HIV, risk factors, syphilis, tattooing, transfusion-transmitted diseases*

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The relation between tattooing and the transmission of certain infectious diseases has been known for many years.[1] Some of the same diseases are also transmitted by the transfusion of blood and blood products. Based on this knowledge information on tattooing has been included in screening interviews of prospective blood donors. In several countries (e.g., Australia and Canada) deferral can result if the donor has been tattooed within the previous 12 months.[2,3] The literature on tattooing and transfusion-transmitted diseases (TTDs) was reviewed to evaluate the published evidence of their association. This article comments on the potential implications in the screening of blood donors, and discusses the usefulness of obtaining more detailed information about tattoos, rather than just the time of the tattoo, in screening prospective blood donors.

MATERIALS AND METHODS

MEDLINE searches were carried out for the period ranging from January 1966 to February 2000, using medical subject heading (MeSH) terms and textwords for "tattooing" and "tattoo" combined with "transfusion," "hepatitis" (or "HBV" or "HCV"), "human immunodeficiency virus" (or "HIV"), "acquired immunodeficiency syndrome" (or "AIDS"), "syphilis," "Chagas disease," "infection," and "risk factors." In the case of words that are commonly known by their abbreviations (AIDS, HIV, HBV, and HCV for, respectively, acquired immunodeficiency syndrome, human immunodeficiency virus, hepatitis B virus, and hepatitis C virus) both the full words and the abbreviations were used, because it has been shown that MEDLINE searches using abbreviations do not overlap completely with full MeSH terms and textwords, and that the yield may contain subsets that are not common to each other.[4] The search made no restriction as to language of publication, but only articles published in English, French, Spanish, and Portuguese were read fully. A few selected articles published in other languages were eventually cited based on the information contained in their English abstract.

Databases, Aidsline (1980–1999), Social Sciences Abstracts (1984–January 2000), Psycinfo (1967–February 2000), and General Science Abstracts (1984–January

2000) were also searched with similar search strategies. Further references not captured by these computerized searches were sought from the bibliographies of the retrieved articles and from textbooks on infectious diseases, internal medicine, hepatology, gastroenterology, and transfusion medicine.

Literature Review

Tattooing

Tattoos have been identified in human beings from ancient times, going back to the stone age.[5] Tattooing is practiced all over the world, although its importance and meaning varies in different societies and has changed over time. Tattoos may occur accidentally, such as those caused by a black pigment contained in the double coating of silicone used as a lubricant in insulin needles,[6] or traumatically, such as blast tattoos that occur when fragments of gunpowder are propelled into the skin during a firearm discharge,[7] but most are intentionally acquired. Several uses of tattooing in medicine have developed over time, mostly for cosmetic purposes. Ornamental tattooing has been popular for a long time among sailors, the military, and also criminals. In Europe and the Americas tattoos and other types of body art, such as piercing, practiced by either professionals or amateurs, have experienced a boom in the past 2 decades. Adolescents of both genders represent a large proportion of tattooed individuals. It has been estimated that approximately 25% of the world's population is in some way or another tattooed.[8] In the United States alone, there are more than 4000 tattoo parlors,[9] and the number of tattooists has been estimated from between 30,000 (taking into consideration only those working in shops and studios) to 100,000.[10] Although tattoos are now frequently observed in the general population, there are still certain groups of individuals in which the prevalence of tattoos is much higher. These groups include prisoners, drug addicts, and psychiatric patients.[11,12]

Tattooing involves piercing of the skin with one or more needles that permanently imprint one or more pigments into the dermis, usually forming a recognizable pattern or design. Pigments or dyes used in tattooing include a variety of substances.[13] Tattoos performed by professionals involve the use of electric tattoo machines, using up to 14 solid-bore needles arranged in a line or bunch, and special dyes.[1,14] Amateur tattooing may involve only a single sewing needle or straight pin and ink from a ballpoint pen ("jailhouse," handmade tattoo) although other equipment, such as homemade tattoo machines, have also been employed.

The majority of tattooed individuals display one or two tattoos, but much higher figures have been reported. Among 202 Australian adults, several had over 150 separate tattoos, going as high as 2000 tattoos.[15] These figures are far from the 9860 individual tattoos sported by the world's most tattooed man.[10] The designs of tattoos have been categorized into artistic, sentimental, macabre, Rabelaisian, and obscene,[16] but this classification has not been frequently used in practice. Animals, names or initials, birds, butterflies, flowers, hearts, daggers, crosses, Zodiac signs, and dragons were common designs found in different series of patients from different regions.[11,17-19] It is not uncommon to see a tattoo imprinted over a previous one that has lost favor ("cover-up work"), which is often the case with names or initials of former friends and lovers.[20]

In the United States, street gangs have their members tattooed with certain designs, such as the "pachuco" mark, a cross with three lines extending above the top, which identify their membership. Baden, a forensic pathologist, studied 1000 drug addict cadavers and claimed that it was possible to distinguish between alcoholics, and hard and soft drug users by the design of their tattoos.[21] According to his study, alcoholics had usually tattooed American flags, ships, eagles, and names, whereas among soft drug users the peace symbol was common and among heroin addicts the pachuco symbol prevailed. In a study from the 1950s, the tattoo of a rose was often associated with alcoholism.[22] Tattoos have been used by drug addicts to cover up drug injection sites.[20]

Sexual preference may be shown by a tattoo. For instance, a question mark on the left ring finger indicates the wearer as bisexual, whereas four dots on the dorsum of the proximal phalanx of a finger on either hand indicates lesbian tendencies.[11] Male homosexuals frequently have tattoos on their buttocks.[11]

The majority of people who have a tattoo obtained it (or their first one) while they were adolescents. Australian adolescents reported a mean age at acquisition of first tattoo of 12.3 years, and the youngest age was 3 years.[15] In a survey of French naval recruitees who had tattoos, the mean age at the time of the first tattooing was 16.5 years.[23] An almost identical figure, 16 years, was found in Wales.[24,25] Although professional tattoos are prohibited in minors in different parts of the world, this prohibition has not affected the practice of amateur tattooing.[9,26]

Some employment opportunities and recruitment to the Armed Services can be jeopardized if the candidate has a tattoo.[27-29] The presence of a tattoo on a patient is immediately associated in the minds of health professionals as a possible marker of drug abuse and infections by agents such as HBV and HIV.[30] The perceived association between tattoos and HIV infection can sometimes lead to shortcuts in medical reasoning and, in consequence, to medical errors. This is exemplified by a recent case report of a young man who had tattoos and a pierced nipple, and was thought to have an HIV infection. This presumptive diagnosis was in part made because of his body art, and only after his condition deteriorated to

a critical level days later was he correctly diagnosed as having type I diabetes.[31]

Diseases Associated with Tattoos

Several infectious and noninfectious diseases have been associated with tattooing. Noninfectious diseases are not discussed in this review. Transmission of diseases from tattooing may be related to the use of needles that were contaminated with blood or saliva of the tattooist or of a previously tattooed individual, or the use of contaminated dyes and other material, such as sponges or tissues used to wipe away blood. The tattooing gun is also a source of contamination. Ideally all the material used for tattooing should be either disposable or sterilized after each use, and the tattooist should wear latex gloves.

Tattooists who are chronic carriers of infectious diseases are important sources of infection associated with tattooing. The prevalence of viral serologic markers of chronic HBV, HCV, and HIV infections among tattooists in Victoria, Australia, in 1984, however, was low.[32]

A large number of microorganisms have been shown to be transmitted by tattooing. The large majority of them were reviewed by Long and Rickman.[1] A list of the tattooing-associated infections recognized to date is shown in Table 1.[1,2,13,33-58]

Transfusion-Transmitted Diseases and Tattoos

Hepatitis B. Early studies on the association between tattooing and hepatitis focused on hepatitis B, for which a serologic marker, initially HBsAg, has long been available. The then-called serum hepatitis transmitted by tattoo needles was responsible for the closing of tattoo parlors in New York State in 1961.[52,59] Outbreaks of hepatitis B associated with inadequate handling of needles and dyes in tattoo parlors have been reported from the UK and Singapore.[33-35] A high prevalence of HBV infection among aborigines who also have a high prevalence of tattoos has been recognized in different parts of the world, such as Australia and Brazil,[60,61] but not in India.[62] Tattooing was suggested to be an important risk factor for the transmission of hepatitis B among gypsies in Spain.[63] Autopsy studies in South Africa and in Australia revealed a high prevalence of HBV markers in corpses that had tattoos.[64,65] Some epidemiologic studies have also found a significant association between tattooing and HBV infection in different settings and populations,[66-73] although others have not.[74-77] Only a few studies have taken into account the role of confounding, and their findings are shown in Table 2. In general, the magnitudes of the relative risk estimates were close to two, except for one study.

Table 1. Infections and Diseases Transmitted by Tattooing

Microorganism	*Infection or Disease*	*References*
Viruses		
HBV	Hepatitis B	33–35
HCV	Hepatitis C	2,36–40
Hepatitis D virus	Hepatitis D	41
HIV	HIV infection	42
Papillomavirus	Warts	43–45
Vaccinia	Vaccinia	13
Bacteria		
Streptococcus pyogenes	Impetigo	1,46,47
	Erysipelas	1,46,47
	Septicemia	48
Staphylococcus aureus	Toxic shock syndrome	49
Pseudomonas aeruginosa	Septicemia	48, 50
Unidentified	Epidural abscess	51
Clostridium tetani	Tetanus	1
Haemophilus ducreyi	Chancroid	1
Treponema pallidum	Syphilis	1,13
Mycobacteria		
Mycobacterium tuberculosis	Tuberculosis	52,53
Mycobacterium leprae	Leprosy	54,55
Fungi		
Sporothrix schenkii	Sporotrichosis	56,57
Saksenaea vasiformis	Zygomycosis	58

Hepatitis C. The transmission of HCV infection through tattooing has been demonstrated or suggested in case reports and case series.[2,36-40] One hospital-based case-control study from Korea and one cross-sectional study among American blood donors did not find an association between tattooing and HCV infection,[78,79] and several others were unable to demonstrate a statistically significant association despite obtaining odds ratios greater than one.[73,80,81] Still other studies have found the association to be statistically significant, although with widely different magnitudes, ranging from 2.5 to 27.[82-90] Ko et al,[83] in Taiwan, found a significantly increasing risk of HCV infection with an increasing number of tattoos and also with tattooing performed by nonprofessional friends as opposed to professional tattooists. The findings of those studies that accounted for the role of confounding by using methods of restriction, matching, or multivariate analysis are shown in Table 3.

Human Immunodeficiency Virus. Transmission of HIV infection attributed to tattooing has been suggested, and it is theoretically possible. Doll reported two cases of HIV infection likely to have been transmitted by tattooing within a prison.[42] Seroprevalence surveys worldwide have shown that tattoos are more commonly found among HIV-positive individuals than in control groups or the general population. These studies, however, are difficult to interpret because adjustment for confounders, such as drug use, is not always done. Only two studies assessed the relative risk estimate of being HIV positive for tattooed individuals compared with those without tattoos. In a cross-sectional study undertaken in two Spanish prisons in Madrid in 1987, among the male prisoners, the adjusted odds ratio was 2.8.[91] In Quebec City, Canada, tattooing was not found to be associated with HIV infection either in male or female prisoners.[92]

Syphilis. Transmission of syphilis through saliva used to moisten tattoo needles by a tattoo artist who probably

Table 2. Adjusted Odds Ratios of the Association between Tattooing and Hepatitis B Infection

Study Population	*Serologic Marker*	*OR (95% CI)*	*Country*	*Reference Year*
Cross-sectional studies				
Adult males	HBsAg	1.14 (0.80–1.63)	Singapore	1988[76]
Villagers	HBsAg, anti-HBc anti-HBe, anti-HBs	1.58 (1.04–2.39)	Sudan	1989[68]
Adult males	HBV markers	8.10 (1.90–34.80)	Taiwan	1990[70]
Blood donors and prisoners	HBsAg, anti-HBs	2.30 (1.30–3.70)	Brazil	1990[71]
Case-control study*				
National registry of hepatitis cases	HBsAg	2.12 (1.10–4.09)	Italy	1995[73]

*Cases and controls were, respectively, patients with acute hepatitis B and patients with acute hepatitis A infection.

had oral mucous patches was reported as early as 1853.[13] Several reports of single cases or outbreaks of tattooing-associated syphilis have followed since then and have been reviewed in detail by Beerman and Lane,[13] and more recently by Long and Rickman.[1] An interesting finding is that in secondary syphilis the lesions may arise in a tattoo, but tend not to exhibit the red areas produced by the use of mercuric sulfide.[13] Mercurial preparations were used before the advent of penicillin for the treatment of syphilis.[93] The association between tattooing and syphilis has not been studied by epidemiologic observational studies.

Chagas Disease. Although biologically plausible, the association between tattooing and Chagas disease has not been demonstrated. The only study to look at the association between tattooing and Chagas disease was a survey of 205 Brazilian conscripts who volunteered to donate blood.[94] This study revealed no association, but as the prevalences of both tattoos (4.4%) and Chagas disease (1.5%) were low in the study population, the study lacked power for the intended assessment.

Other Diseases. Tattooing was found to be significantly associated with hepatitis D virus infection, but not with GB virus/hepatitis G virus infection in Taiwanese prostitutes.[41,95]

Evidence of Association between Transfusion-Transmitted Diseases and Tattoos

There exists sufficient evidence in the literature that HBV and HCV infections and syphilis can be transmitted by tattooing when performed with contaminated material or by tattooists who are carriers of these microorganisms. Human immunodeficiency virus infection has probably also been transmitted by tattooing, but this observation remains equivocal. Several epidemiologic studies have shown a statistically significant association between tattooing and TTDs, although the odds ratio estimates have widely different values. As these studies have been carried out at different times, and in different settings and study populations, this heterogeneity could explain, at least in part, the discrepancies in the findings from the different studies. It is known that the prevalences of different TTDs vary sometimes substantially between different countries or regions within countries, and among different population groups. The same applies to the prevalence of tattooing in different populations and times.

Table 3. Adjusted Odds Ratios of the Association between Tattooing and Hepatitis C Infection

Study Population	*Serologic Marker**	*OR (95% CI)*	*Country*	*Reference Year*
Cross-sectional studies				
Blood donors	ELISA, RIBA	27.00 (8.40–87.00)	Australia	1992[82]
Military recruits	ELISA	5.90 (1.60–22.00)	Taiwan	1992[83]
Prisoners	ELISA-2	5.44 (1.68–9.21)	Norway	1993[84]
Blood donors	ELISA-2, RIBA-2	†	UK	1994[85]
Pregnant women	ELISA-3	3.50‡	Australia	1997[90]
Patients from referral center for liver diseases	ELISA, RIBA-3	8.43 (2.12–33.66)	Brazil	1999[86]
Nationwide survey	ELISA-2	3.10 (0.70–13.30)	Taiwan	1999[81]
Case-control studies				
Blood donors	ELISA, RIBA-2	3.30 (1.20–8.70)	UK	1994[87]
National registry of hepatitis cases	ELISA(?)	2.50 (0.80–7.79)	Italy	1995[73]
Patients from teaching hospital	ELISA-2, RIBA-2	1.10†	Korea	1996[78]
Patients from teaching hospital	ELISA-2, RIBA-2	5.90 (1.10–30.70)	US	1999[88]
HCV-infected patients and their household contacts	ELISA, RIBA-2	2.50 (1.10–5.60)	Italy	1999[89]
Blood donors	RIBA	5.70 (2.50–13.00)	Canada	1999[90]

ELISA = enzyme-linked immunosorbent assay; RIBA = recombinant immunoblot assay.
*Numbers 2 and 3 after serologic markers indicate second and third generation, respectively.
†OR and 95% CI not provided; P < 0.05; ‡95% CI not provided; P = nonsignificant.

If the prevalences of tattooed individuals and of the infection of interest in the study population in a given study are low, then the study might not have enough power to determine a precise estimate of the odds ratio, and therefore, it is likely to be unable to demonstrate a statistically significant association. As tattooing has seldom been the variable of major interest in previous studies, some degree of misclassification of exposure (having or not having a tattoo) might also have occurred in some studies. Misclassification of the outcomes is also a possibility, given that the laboratory tests are not 100% sensitive and specific, notwithstanding the fact that the large majority of the studies used state-of-the-art diagnostic tests at the time they were undertaken. Misclassification of exposure or outcome, if nondifferential, should have underestimated the true odds ratios, which is a possible explanation for the finding of no association between tattooing and TTD in some studies.[96] On the other hand, selection bias and inadequate adjustment for confounding factors also may have played a role in some studies, and if so, might have biased the odds ratio estimates either by overestimating or underestimating them.[96]

Tattoos and Screening of Blood Donors

Because of the potential risk of transmission of infectious diseases, the presence of tattoos has been used as a criterion for deferral of blood donors. History of tattooing in the preceding 6 months is among the 10 top causes of deferral of blood donors in Singapore.[97] In Canada and in Australia, individuals who were tattooed during the preceding 12 months are not accepted as blood donors. This period of temporary deferral has been established after taking into account the window period during which an infected (and infective) individual might be seronegative.

However, the use of information on tattoos could provide much more information than the simple fact that someone might have acquired a TTD by a tattoo and is within the possible infective window period when volunteering for a blood donation. Tattoos are correlated with other risk factors for TTDs, particularly intravenous drug use and incarceration, which are also correlated to each other and are both risk factors for HBV, HCV, and HIV infections and syphilis. The occurrence of these infections is, in turn, intercorrelated.[98-101] The prevalence of these infections among prisoners is extremely high. There is strong evidence that these infections have actually been transmitted to individuals while they were incarcerated,[102-105] although there is also evidence that, at least for HCV infection, the majority already had the infection before they were sent to jail.[106] The transmission of TTD probably varies according to the conditions of the prisons. In Peru, Lima's largest prison accommodates approximately 6000 prisoners in a place designed for 1600; the place is basically run by the inmates and, on visiting days, prostitutes are permitted to have sex with inmates at will. Unprotected sex between males, intravenous drug use, and tattooing are commonplace in this setting.[107] In Brazil, the conditions in São Paulo's largest prison, Carandiru, are similar.[108] Other examples from both developing and developed countries abound. About 20% of the prisoners in France and in New South Wales, Australia, in 1996, reported having injected drugs while in jail, frequently sharing needles.[109,110] In fact, several countries have adopted the policy of authorizing the use of bleach in prison for cleaning injecting equipment and, at least in principle, for preventing the transmission of HBV, HCV, and HIV infections.[109,110]

Tattooing, therefore, can be an important surrogate for risk factors such as drug use and incarceration, and to a lesser extent also for at-risk sexual behavior and a history of sexually transmitted diseases. For the purpose of screening of blood donors, contrary to other risk factors whose presence depends on information provided by the prospective donor, the presence of a tattoo can be determined objectively by direct observation. In other words, tattooing can be objectively measured, whereas the other indicators are likely to be subject to greater measurement error given that sexual behaviors and habits that are perceived as socially undesirable are likely to be underreported. Information on tattooing is useful for screening purposes also because it may avoid the donation of contaminated blood by individuals who omit to mention at the screening interview the fact that they have been exposed to certain risk factors.

An interesting field of research that has not been explored is whether studying tattoos in more detail could provide useful information as to the identification of people who are carriers or have seromarkers of TTDs. It has been noted that an increasing number of tattoos is associated with an increasing risk of HCV infection, and that the same infection is associated with amateur-made tattoos as compared with professional-made tattoos.[71] It has been mentioned that certain tattoo designs have been associated with behaviors, such as sexual preference and intravenous drug use.[11,20,21] The in-depth study of those who have tattoos (in particular the number of tattoos, their type (professional vs. amateur), design, timing, and the conditions in which they were performed) might provide a better understanding of tattooing as a risk factor for TTDs. It might also identify subgroups of tattooed individuals who have an increased risk of TTDs. This information could eventually be useful for the screening of blood donors in that it would eventually permit the distinction among prospective blood donors who sport a tattoo of those with a higher or a lower risk of having a TTD seromarker. This would optimize the screening algorithm and make the process more cost-effective, given that only those tattooed individuals identified as being at high risk of testing positive for a TTD would not be

eligible for blood donation, whereas the unnecessary deferral of those at low or no risk would be avoided.

Such optimization of the screening process is likely to become more important in the near future. As tattoos become more common in the general population and as professional tattooers become more aware of the risks of infectious diseases associated with tattooing, it is possible that the risk factor profile of tattooed individuals will change. An ongoing process of reviewing screening criteria in light of scientific evidence and new technology will help to optimize voluntary blood donations while continuing to ensure a safe and sustainable blood supply.

CONCLUSION

Over the past 2 decades, tattoos have become more common among adolescents and young adults of both genders, and are also found among other age groups. The unequivocal risk of transmission of several infectious diseases by tattooing has clearly been shown and can be prevented if tattooing is performed by trained artists using adequate equipment under adequate sanitary conditions. Because tattoos are also a marker for certain risk factors of TTDs, tattooing has been used as a criterion for deferral of prospective blood donors. Furthering understanding of tattoos as a risk factor for TTDs in current society will make an important contribution in the ongoing process of reviewing the screening criteria for blood donation.

"Safe blood saves lives," the motto of the World Health Day 2000,[111] summarizes in a few words the enormous importance of the availability of reliable blood for transfusion worldwide. Prevention of TTDs has much to do with safe blood. Further studies, in different settings, that examine tattoos in more detail are required to establish the usefulness of this risk factor as a screening tool in blood donation.

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